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ABSTRACT

This case study suggests that there are important links between students' perceptions and metacognitive development. David was one of five students who were interviewed in the second semester of a second year chemical engineering course in which the fundamental concepts of the discipline are first encountered. This paper assesses David's way of understanding supported by an examination of his perceptions and interpretations of a number of different aspects of the course. Specifically, analyzing David's experience has shown how it is possible for inappropriate perceptions to seriously hamper metacognitive development. Uncovering and engaging with student perceptions is therefore an important dimension of teaching for enhanced metacognition. (CCM)

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The impact of students' perceptions on their metacognitive development: a case study

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INTRODUCTION

After completing a demanding second year chemical engineering subject a number of students were interviewed about their perceptions of aspects of the course. Here is an extract from an interview with one of the students, David (pseudonym).

> I was scared that CPA [the subject], you know many people they will tell you that CPA is difficult, so, I was like making sure that every day I do stuff. But during the course of the year I realised that the course is just fine. Especially the person who was lecturing it is very good, she stopped during the lecture, and she asked questions, she looked around, and she gets you to follow the stuff very well. I was more relaxed than before, than last year. Cos, you know, many lecturers they tend to deliver the stuff, and then it's up to you... But uh [the lecturer] was like hey, she used to stop during the lecture, and then... Actually in fact I would say, I was doing most of my work in the lecture, ja cos that's where I was getting more information, cos I used to listen [more] than to write

As is clear from the extract, David saw the teaching of the subject in positive ways. The extract suggests that he appreciated, and perhaps understood, the ways in which the lecturer of the subject had approached teaching the class. From this extract one might infer that David was a successful student. Quite the contrary – unfortunately he failed the subject outright, and knew this at the time of the interview from which the extract is taken.

One of the central concerns of the lecturer in her teaching of this subject was to have students better understand their own learning. In this context David, whose experience of his learning and achievement seems to be so much at odds with his results, is a revealing case study.

THEORETICAL FRAMEWORK

Marton and Säljö's (1976) seminal constructs of deep and surface approaches to learning were first introduced to a mainstream higher education audience in the book "The Experience of Learning" (Marton, Hounsell, & Entwistle, 1984). In this same text, Paul Ramsden brought to the fore the relationship between students' perceptions of the educational environment and their approaches to learning (Ramsden, 1984). His formulation of this relationship provides a powerful argument for explaining the frequent divergence between high-level course objectives and students' learning outcomes in practice. Students respond and react to the situation they perceive, which is frequently quite different to the course as defined by the lecturer. Explanations of student learning will not be found in supposed objective features of a course, but in what students have constructed out of this as a result of their perceptions.

Ramsden is careful to trace the historical antecedents of this 'new' addition to the student learning conceptual framework, and refers both to classic critiques of higher education from scholars such as Cardinal Newman and Thorsten Veblen and sociological studies emerging later in the climate of student unrest of the late 1960s and early 1970s. Notable in the latter category are the studies by Snyder (1971), Becker et al. (1968) and Miller and Parlett (1974). In research done at MIT in the early 1960s, Snyder (1971) uncovered a contradiction between the messages coming from the formal goals of the curriculum and those messages communicating what actually had to be done in order to attain academic rewards. He uses the terms

'formal' and 'hidden' curriculum to distinguish between the learning context as defined formally by teachers and that perceived by students. The work of Miller and Parlett (1974), focusing on students' responses to the examination context, can be seen as an extension of the notion of the hidden curriculum. In this context, the hidden curriculum manifests itself as a series of 'cues' given out by staff. They found that not all students responded in the same way to these cues, and identified three different groups of students in this regard. The first group of students, which they termed 'cue-conscious', were receptive to cues sent out by staff. The second group, 'cue-seekers', took cue-consciousness one step further and actively interacted with staff to elicit cues. The final group was termed 'cue-deaf' because, to all intents and purposes, they were completely unaware of cues. Becker et al. (1968) also identified the centrality of assessment concerns in the student's view of the academic environment. Defining perspective as "a co-ordinated set of ideas and actions a person uses in dealing with some problematic situation", they uncovered a dominant set of ideas amongst students which they termed "the GPA[1] perspective". In this perspective, students defined the learning context as an exchange of rewards (marks) for performance, rather than as any sort of learning process involving personal growth.

Ramsden represents the relationship between students' perceptions, approaches to learning, and learning outcomes in the diagram given in figure 1. This model is clearly derived from Biggs' 3P model of student learning (the present version of Biggs' model can be found in Biggs, 1993), although it is Ramsden who has highlighted the central role of perception. Ramsden describes perception as the "point of contact" between the educational context and student experience, and also refers to perception as a "relation" between these two domains (Ramsden, 1988, p160). He identifies three different "interconnected levels" of the educational context, viz assessment, teaching and curriculum, and this provides his basis for analysing and describing students' perceptions.

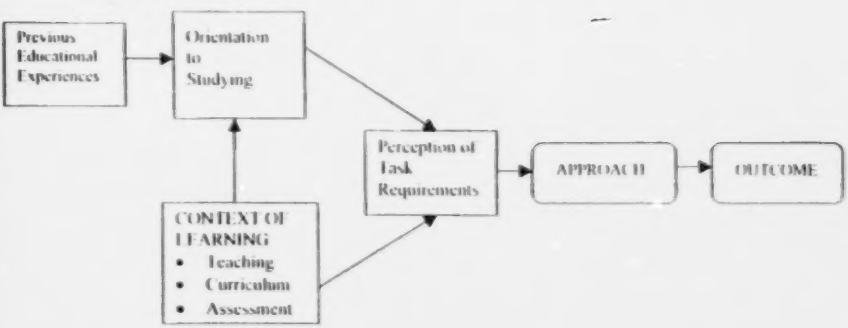

Figure 1: A model of student learning in context (Ramsden, 1992, p83)

[1] Grade Point Average: combined average mark for all courses taken; used to determine progress and graduation in certain US universities.

It is interesting to compare the latest version of Ramsden's model given here with a previous version published four years earlier (Ramsden, 1988, p161). In the earlier version Ramsden has "student experience" in place of both "previous educational experiences" and "orientation to study". His earlier version is also broader in its use of "perception" instead of "perception of task requirements".

Ramsden's work on the importance of student perception has provided an important dimension to the current understanding of student learning, and indeed provided the starting point for the broader study to be described in this paper. This model is useful in pointing out the links between perceptions, approaches and outcomes, but is limited in its description of perception itself. Perception can be represented by the section on the left of figure 1, but in Ramsden there is not much further clarification on what is meant by perception other than a "point of contact" or a "relation". The only route for analysis suggested by Ramsden is the classification according to the three dimensions of context described above.

Ramsden's description of perception is also theoretically ambiguous in that he alternates between a dualistic and non-dualistic stance. Although he argues elsewhere for a 'relational' perspective, in which learning is seen as a *relationship* between learners and subject matter, and in places refers to perception as a 'relation' between students and their context (non-dualistic), the formulation represented in figure 1 seems to suggest a separation between individuals and the world around them (dualistic). In the context of higher education, Marton (1995) has pointed out the philosophical problems with a dualistic ontology by referring to the classic problem of Meno's paradox, which is centred around the question "How can we gain knowledge about the world?". Plato showed that it is impossible to gain such knowledge unless we already possess it, as we would otherwise have no way of recognising such knowledge. Marton's solution to this problem is to adopt a non-dualistic stance, in which there is no separation between individuals, the world around them, and their perceptions of the world.

On a more practical level, we would suggest that a dualistic view of perception leads directly to notions of 'blaming the student', since problems with learning can be located solely with the student. On this note we would find problems with Ramsden's use of 'orientation to study' in this framework, which is a relatively stable characteristic which students bring to a context. If one places an understanding of student learning within a non-dualistic framework, it is not possible to make such a judgement, since learning is seen to result from the interaction of a student and a particular context, a composite whole from which different components can't be isolated. Marton (1988) has stated this point as follows:

> If we were to think about approaches and conception as something located within the individual, as it were, it would make a lot of sense to try to change the individual or to try to changing something *in* him or her, given that our aim is to improve learning. The alternative is to try to change the individual's experience, perception, or conception of *something* (Marton, 1988, p75, emphasis in original)

A non-dualistic approach to questions of perception can be found in phenomenology, and its higher education offshoot, phenomenography. In this non-dualistic worldview, experienced phenomena are considered to comprise an "internal relationship between the subject and the world" (Marton & Booth, 1997, p122). Prosser and Trigwell have attempted to reconcile the model in figure 1 with a non-dualistic perspective, by

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suggesting that the components in this model are simultaneously present in any act of teaching and learning, with certain components in the foreground of awareness at a given moment in time (Prosser & Trigwell, 1999). We do not think that this is a satisfactory resolution of the philosophical problems with this model. Prosser and Trigwell's formulation deals with students' awareness of perception, context, orientation to study, etc. Although students' awareness of their learning is of relevance in considerations of the reflection and metacognition, this does not provide a general framework for considering perception (which, following the phenomenographers, we take to be synonymous with awareness, consciousness, and experience). In other words, we are interested in perception more generally, not only in students' awareness of their perceptions.

A more philosophically grounded model of perception can be found in the work of the phenomenologer Aron Gurwitsch (1964). In his analysis of human consciousness, Gurwitsch divides the totality of perception at a given instant (the 'perceptual noema') into a theme, thematic field, and a margin. The theme is that which currently occupies the individual's focus, and the thematic field is the set of ideas and images co-present with the theme which are related to the theme. For example, when focusing on a stoichiometric problem based on the formation reaction of ammonia (the theme), items present in a chemical engineering student's thematic field might include the relations between mass and moles of a gas, the concept of incomplete reactions, strategies for balancing a reaction equation, the physical arrangement of the reactor, and so on. The margin comprises that which is simultaneously present with the theme, but has no relevance to it. For the purposes of this research we are primarily concerned with the theme and the thematic field, although of course, as we all know, when students' weekend plans are present in the margin of the awareness this can have a considerable impact on the ability to stay focused on the theme of stoichiometry. Marton and Booth (1997) suggest that the thematic field be considered in terms of 'constituent fields' related to the theme according to relevancy. These constituent thematic fields "extend into the very life world of the learner, both back into her learning history and forward into the way she proceeds with her learning" (p99). The relationship between the theme, the thematic field and the margin has been represented by Booth (1992) in the diagram in figure 2.

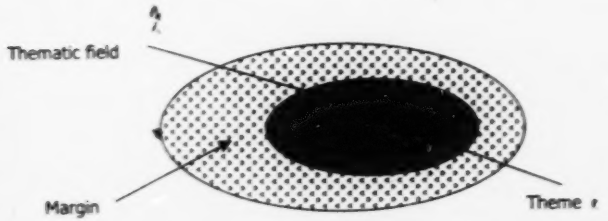

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Figure 2: A stylised view of Gurwitsch's field of consciousness (Booth 1992)

A particular theme could have a variety of different thematic fields associated with it, depending on the individual's background and intentions, and it is the specific thematic field generated by an individual that determines the *meaning* that they have for that theme. In phenomenographic terms, it can be said that a particular way of experiencing something is related to differences in the organisation or structure of awareness (Marton & Booth, 1997). Structure refers here to the relationships between the aspects that are simultaneously present in the individual's focal awareness (theme and thematic field).

Using this view of perception, Marton and Booth (1997) reconceptualize deep and surface approaches to learning in terms of what is in the learner's focal awareness. In the context of reading a text, a deep approach means that the learner focuses on the words of the text, the meaning of the words, and the broader phenomena associated with the text, while in a surface approach it is only the text that is in focal awareness. They conclude that: "More advanced ways of experiencing something are, according to this line of reasoning, more complex and more inclusive (or more specific) than less advanced ways of experiencing the same thing, 'more inclusive' and 'more specific' both implying more simultaneously experienced aspects constituting constraints on how the phenomenon is seen." (Marton & Booth, 1997, p107.)

CONTEXT FOR THIS STUDY

Material and Energy Balances (CHE231F) is a second year chemical engineering course in which the fundamental concepts in this discipline are first encountered in depth. This is a course with a notorious history and legendary campus status, such that students still refer to it as 'CPA', even though the course name changed from this in 1995. The lecturer responsible for the course in 1998 decided to do something to address the traditionally high failure rates and low level of retention of fundamental concepts. She adopted an approach to teaching, curriculum and assessment that was informed by current research on student learning. The course emphasis was shifted from focusing solely on problem solving, to include a strong focus on conceptual understanding.

Students' prior experiences in first year courses would have stressed problem solving (albeit of a narrow, algorithmic close-ended kind), and the lecturer realised that changing the focus in CHE231F towards conceptual understanding would require development in students' conceptions of and approaches to learning. This development was conceptualized as metacognitive development, using Baird's (1990, p184) formulation of metacognition as "the knowledge, awareness and control of one's own learning".

A starting point in these changes was to reduce the course content by 25%, with the agreement of the Department of Chemical Engineering, in order to allow for teaching and learning in accordance with these changed emphases. The lecturer also adopted interactive approaches to teaching and learning, and incorporated student journals in the course in order to make the focus on metacognitive development explicit. Recognising the critical role played by assessment in determining students' approaches to learning she made some changes to the assessment methods in order to stress conceptual understanding. The test format was changed to include a significant number of 'conceptual questions', which were non-numerical and usually required

written explanations. One class test was completed under conditions of practically "unlimited time" (students were allowed up to five hours for a test designed to take two hours).

AIMS AND METHOD

David was one of five students who were interviewed in the second semester of 1998, after the course had ended. The purpose of these interviews was to get students to reflect back on their experience of CHE231F, especially now that they had written the final examination and received their results. David was the only one of these five who had not passed the course. During the interview David volunteered his reasons for why he had failed the final examination although he felt that he understood his work. After looking at the transcript of David's interview, it was decided that it would be useful have the lecturer's interpretation of his final examination performance. Without knowledge of what David had said, she was asked to comment on his examination script.

In a previous paper based on all five interviews, and journal submissions from the whole class, a picture of the kinds of metacognitive development experienced by students in this course was developed (Case, Gunstone, & Lewis, 1999a). Most students showed significant development in terms of their views on learning, and their perceptions of the purposes of the various activities in the course (lectures, tutorials, journals, homework tasks, assessments etc). During this analysis it became clear that David's actual process of metacognitive development during CHE231F was not as extensive as those described by the others (contrary to what we expected given his enthusiastic engagement with the course as illustrated in the introduction). In the present paper we therefore aimed to investigate whether David's perceptions of the course might be able to explain his limited metacognitive development.

RESULTS

The key issue underpinning David's experience of the course appears to be the meanings that he held for the term "understanding".

As described earlier, the lecturer had structured the teaching and assessment in this course to stress conceptual understanding. This focus was reflected in the discussion of concepts in class, the questions posed in tutorials and journal tasks, and type of assessment items used in class tests and the final examination.

David frequently used the word "understand" when talking about his experience in CHE231F, and felt that understanding was important. His very first statement in the interview, when asked to talk about his experience of CHE231F, was that

> it is a fundamental course in engineering ... you get to **understand** most of the concepts of the chemical engineering, especially ... mass and energy balances. (emphasis added)

He did not ascribe failing the final examination to a lack of understanding; on the contrary he felt that "I understand mostly everything ..."

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However, when asked to comment on his examination script, the lecturer's main comment was that his understanding was grossly inadequate, responding to his answers to various questions with "He hasn't really got an idea of what he's doing", "He's just fishing in the dark", "He's got the wrong end of the stick" etc.

How can we reconcile this apparent contradiction? How could David feel that he understood "mostly everything" while the lecturer who marked his script feel that he "didn't really have an idea"? One logical possibility is that while David picked up that understanding is critically important in this course, his meaning for what constitutes understanding was quite different to that intended by the lecturer.

From his examination script it is clear that David had taken quite some effort to memorise key definitions and formulae – quite frequently this is all that he put down in response to a number of questions that required problem solving of a given situation. David's comment that "what I wrote in the final exam I got full marks for it" would therefore seem to suggest that he felt that these sorts of answers were adequate, and therefore that he equated "understanding" with remembering relevant definitions and formulae. In Gurwitsch's terms, when David was talking about "understanding" the associated thematic field contained references to remembering and being able to reproduce various kinds of information. When the lecturer used the term "understanding" she simultaneously invoked ideas about being able to use concepts in any context, being able to explain something, etc. In phenomenographic terms, David and the lecturer had different ways of experiencing the phenomenon of "understanding". Using Marton and Booth's most recent theories of awareness, these different ways of experiencing were due to different structures of awareness, and the lecturer's awareness was broader and more inclusive, while David's was somewhat limited.

This assessment of David's way of experiencing understanding is supported by an examination of his perceptions and interpretations of a number of different aspects of the course, discussed in turn in what follows.

Experience of the lecture

Compared to how other CHE231F students came to the realisation that lectures were not the most important part of the course (Case et al., 1999a; Case, Gunstone, & Lewis, 1999b), David found the lectures were so useful that there was not much that had to be done outside class (see quote in introduction). This experience he compared with another course that he was doing in the second semester (at the time of this interview), where the lectures were given in a traditional manner, and where he felt that he had to do more work on his own and to concentrate on the tutorials.

We can understand David's perceptions of the role of the lecture by referring to his notion of "understanding". When David sat in the lecture, he felt that what happened here was sufficient to build adequate understanding – because in his terms having an overall idea of the formulae and definitions constituted understanding. Other students felt that the lecture provided only a starting point and that their real learning happened in the tutorials and when working at home, and this was due to a more inclusive set of meanings that they had for the term understanding (Case et al., 1999a). In David's experience of more traditional lecturing what happens in classes is apparently not sufficient for him to develop his "understanding" as he defines it (and presumably the

aims and assessment of these courses is such that David's meaning for 'understanding' is sufficient to be able to pass).

Explanations for assessment performances

When David was faced with poor assessment results (he only passed the first test), it did not generally occur to him that this could be due to inadequate understanding, since in terms of the meaning he held for the term, his 'understanding' was adequate (he could recall the relevant information). He therefore sought explanations elsewhere. Examination technique provided the chief way in which he interpreted his failure in the final examination. He felt that he had struggled with time, had been penalised for poor layout, and answered questions in the wrong places. It has already been pointed out that the lecturer felt that the main problems in his examination performance were his lack of both conceptual understanding and his problem-solving skills. On these points she agreed that he had struggled a little with time in that he tended to be a bit long-winded, but that this wasn't the chief reason for his failure. He had left out quite a few questions, but what he had completed was far from satisfactory. This contrasts with David's belief that "what I wrote in the final exam, I got full marks for it". Of the other reasons identified by David, the lecturer felt that his layout was in fact above average, and that if anything this had helped him to score marks, and that there was no evidence of any answers being in the wrong sections.

The unlimited time class test presented an interesting experience for David. Because the time explanation had been effectively removed, he had to seek explanations elsewhere:

> In fact, I finished the paper one hour before. So it's maybe because I didn't understand the fundamentals of energy balance, and that was the problem.

This test therefore had David thinking about understanding in a different way, but unfortunately it was an isolated incident, and in the final exam he reverted to his usual assessment that his understanding was adequate. It is interesting to consider whether or not David's way of experiencing understanding might have been more seriously challenged had he had more experiences like the unlimited time test.

Judgement of standard of course

In terms of judging the standard of the course, David had a pre-subject view of the course as "difficult" (see initial quote). After the first test, which was widely recognised to be relatively easy, he relaxed, as did many students. However, while other students revised their opinions after the second and third tests, David continued to feel that this was an easy course. He failed both of these two latter tests, and ended up with a 50% course mark (average over the three class tests). David chose to base his expectations for the examination on this course mark, not on the fact that he had failed two out of three tests:

> So I got like 50% and was standing the chances to pass.

Once again we would interpret this apparent poor judgement in terms of David's meanings for 'understanding' which linked with his expectations of the standard of understanding required to pass in the course.

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Plans for repeating the course

When asked how he planned to tackle the course when repeating it next year, he said that he planned to do more practice, and to read ahead about what is to be covered in lectures. He did not feel that he had to do anything differently to this year (as he "understood" the work) but just needed to work harder. It is not clear what he will work harder at, other than approaches used in failing the course. But because he ascribed his failure to things like time pressure, he assumed that for example learning to work faster will ensure a pass.

METACOGNITIVE DEVELOPMENT

When faced with a question about personal change and development, David seemed unable to engage with this question. He was asked "Are there are any other things (apart from working with other students) that you have done differently this year, or are you working fairly similarly to last year?" At first said he didn't understand the question, then when it was rephrased, he mentioned how initially he was scared, but then with the way the course was presented he relaxed. By comparison, evidence from other students in the class (from interview transcripts and journal extracts) suggests that many students were able to reflect explicitly on how they had developed during the course in their view of learning.

It is important to remember that David engaged enthusiastically with many "metacognitive" activities during the course: he felt positive about the journal tasks, and valued working in groups. Yet his fundamental perceptions of a key phenomenon in this course, "understanding", remained unchanged despite these experiences, and we would suggest that this is the fundamental issue underlying his limited metacognitive development.

We are left with the question as to why David's perceptions of "understanding" remained unchanged by a course environment which had this as its explicit focus. We would suggest that the answer to this might be found in considering David's experience of assessment in the course. In any course, traditional or non-traditional, it is assessment that is most formative of students' perceptions (Ramsden, 1992). The assessment in this course (three class tests and a final examination) had been changed in some aspects in order to reflect the new course emphasis. "Conceptual questions" which required explanations rather than numerical calculations comprised a significant portion of all assessments, and the term "conceptual" was consistently used by the lecturer to emphasize this difference. Yet most assessments were unchanged with respect to their demands on working under time pressure, with the significant exception of the untimed test. This allowed David an explanation for his poor performance which did not challenge his perception of understanding. We have noted above how the untimed test forced him to form a different perception, yet that was an isolated experience, and did not seem to affect his perceptions in the long run. We would suggest that a course environment where this was the normal experience of assessment might have resulted in more productive perceptions of "understanding" for a student like David.

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CONCLUSION

This case study suggests that there are important links between student perceptions and metacognitive development. Specifically, analysing David's experience of CHE231F has shown how it is possible for inappropriate perceptions to seriously hamper metacognitive development, in the context of a course where this aim was actively pursued by the lecturer. Conversely it can be asserted that those students who showed significant metacognitive development (Case et al., 1999a) had developed perceptions of 'understanding' that were appropriate and productive. We would therefore conclude that student perceptions are a critical precursor to and influence on metacognitive development. We have also provided supportive evidence for Ramsden's assertion that assessment is the most important determinant of student perceptions. Uncovering and engaging with student perceptions is therefore an important dimension of teaching for enhanced metacognition.

Gurwitsch's (1964) model of consciousness and the specific interpretations suggested by Marton and Booth's (1997) analysis of awareness have provided a useful theoretical framework for considering students' perceptions. This perspective is quite different to a dualistic perspective, in which perceptions are seen as mental entities that students bring to the context; in the non-dualistic framework perceptions are considered to be intimately related to the student and the context, and inseparable from either. Apart from the theoretical considerations, we would suggest that this framework is productive in terms of moving us as lecturers and researchers away from ways of thinking in which blame for poor educational performance resides solely with the student. It also doesn't allow for the measurement of stable and fixed characteristics that students bring to the course context, a research approach which we consider to have limited utility for improving learning and teaching in real world situations. The unavoidable consequence of an analysis such as that presented in this paper is our consideration of our own roles in shaping the contexts in which students' perceptions are formed.

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